PERFORMANCE ASSESSMENT OF VISION BASED NAVIGATION FOR HAZARD AVOIDANCE DURING LUNAR AND MARTIAN LANDING

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ABSTRACT

Technologies for planetary landing have been studied and developed since the late fifties during the Moon race, which culminated in 1969 with the first human landing on the Moon. Nowadays, instead of humans, small probes/landers are sent to distant planetary bodies, as more recently to Titan and Mars. These landings are often performed by a pre-programmed time sequence of events that bring the lander to a full stop in a desired area at the planet surface (e.g. 'pathfinder-type' is a open-loop landing with airbags; 'Viking-type' a semi-automatic landing).

Future exploration missions envisage landing on planetary surfaces that are not known apriori, or in areas that are not flat and hazard free as the nominal selected Landing Sites (LS) of the current exploration missions. Landers also tend to become smaller and lighter, not so robust to surface hazards. Autonomous pinpoint soft-landing systems that include Hazard Avoidance (HA) capability are therefore required to guarantee safe landing.

Hazard Avoidance is a key technology for a safe landing of future planetary missions. An HA system is responsible for the detection of any hazards that put in risk the landing mission and path-planning to avoid the detected hazards. Hazard detection implies the lander to be equipped with proper sensing devices. In the frame of this study, an optical sensor (onboard camera) is used to detect hazards (e.g. craters, rocks, boulders, high slopes, etc.) in the landing zone.

During Hazard Avoidance, sensors and computers onboard the lander are used to detect hazards in the landing zone, autonomously select the most suitable region for landing, and generate the trajectory that retargets (if needed) the lander to the safer landing site. In this paper, vision-based hazard avoidance algorithms are briefly described, and the results of a consolidated performance assessment under two realistic simulated scenarios representing a landing on Mars and Moon are presented. Results show that the developed Hazard Avoidance algorithms are effective at detecting hazards and guiding the lander to a safe landing site.